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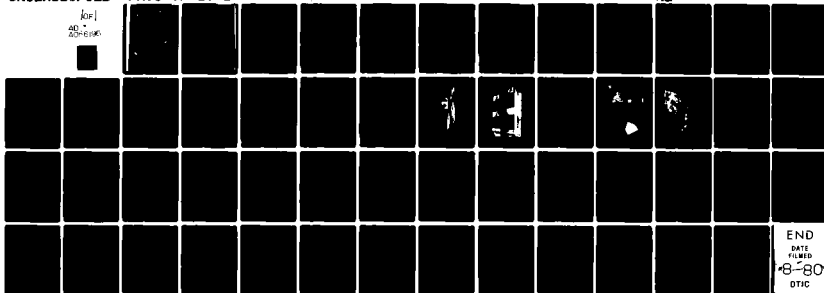
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**PACIFIC MISSILE TEST CENTER ENERGY PROJECTS.**

**Summary of Projects, Contributions, and Plans**

**Technical publication,**  
Compiled By

**JAY ROSENTHAL**

Geophysics Division, Engineering Operations Department

**CRAIG SAVANT/ENSIGN, CEC, USN**

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January 1980

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**PACIFIC MISSILE TEST CENTER**

Point Mugu, California 93042

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# PACIFIC MISSILE TEST CENTER

AN ACTIVITY OF THE NAVAL AIR SYSTEMS COMMAND

This report is a compilation of the projects undertaken at the Pacific Missile Test Center to conserve energy, develop and apply alternative energy sources, and develop, in the 1980s, basic capability (BACADE) projects for applying energy-saving technology to the needs of the Pacific Missile Test Center.

Mr. D. A. Lea, Associate Geophysics Officer; CDR J. B. Tupaz, Geophysics Officer; Mr. C. G. Elliott, Project Manager; CAPT M. M. Dallam, Staff Civil Engineer; Dr. T. C. Lockhart, Associate Range Operations Officer; and Mr. W. L. Miller, Associate Director, Range Directorate, have approved this report for publication.

**THAD PERRY**  
*Technical Director*

**J. M. TALLMAN, CAPT USN**  
*Acting Commander, Pacific Missile Test Center*

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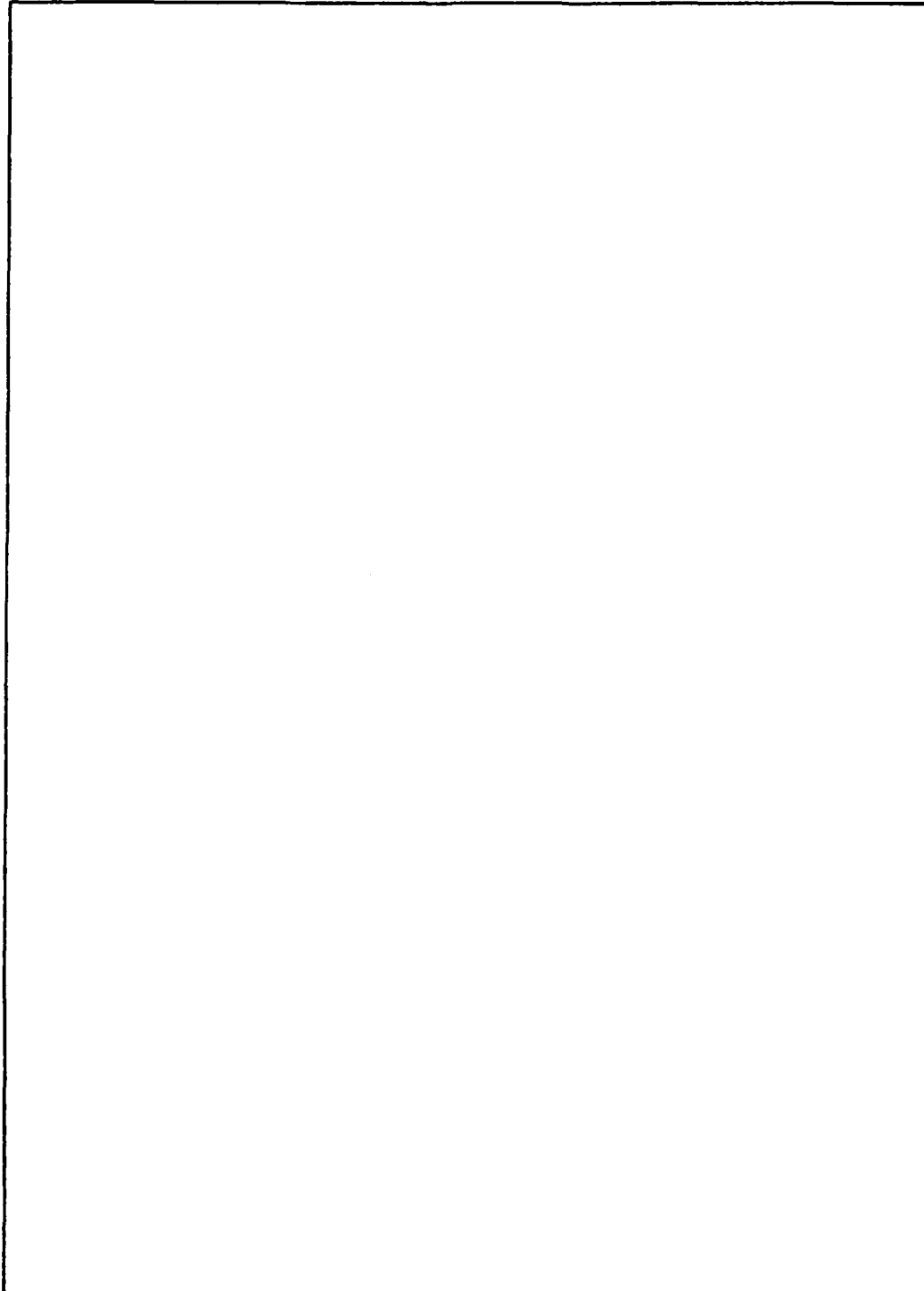
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## ACRONYMS

BACADE	Basic Capability Development
CEL	Civil Engineering Laboratory
DOD	Department of Defense
DOE	Department of Energy
ECIP	Energy Conservation Investment Program
FPUP	Federal Photovoltaic Utilization Program
MERADCOM	Mobility Equipment Research and Development Command
NASA Lewis	NASA's Lewis Research Center
NAVAIR	Naval Air Systems Command
NAVMAT	Headquarters, Naval Material Command
NWC	Naval Weapons Center
PACMISRANGFAC	Pacific Missile Range Facility
PACMISTESTCEN	Pacific Missile Test Center
RDT&E	Research, development, test and evaluation
SAB	Scientific Advisory Board
SNI	San Nicolas Island
UPS	Uninterruptible power supply



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May 1980

**PACIFIC MISSILE TEST CENTER**  
Point Mugu, California 93042

**PACIFIC MISSILE TEST CENTER ENERGY PROJECTS**

**Summary of Projects, Contributions, and Plans**

Compiled by

**J. ROSENTHAL and ENS C. SAVANT**

**SUMMARY**

Skyrocketing fossil fuel costs, double-digit inflation, and a growing vulnerability to curtailment of foreign oil and gas sources have combined to make the Navy's future energy supply uncertain.

The full impact of the PACMISTESTCEN's contributions to the development, test, and evaluation of naval weapon systems can be realized only if the available energy and financial resources are sufficient to exploit its capabilities. Since first priority on Navy supplies must go to Fleet ship and aircraft units, the energy pinch is most severe on the Shore Establishment. Therefore, a practical, continuous effort in energy conservation and application of alternative energy sources is considered to be in the best interests of the PACMISTESTCEN. As early as 1970, the Center's Geophysics Division obtained funds to provide Laguna Peak wind data; to compile climatology of wind statistics; and to develop generalized computer software techniques for computing climatological statistics for evaluation of wind energy potential. In 1973, an energy conservation program was established and is continuing at the PACMISTESTCEN. It has proved to be highly successful. This program and various alternative energy programs are discussed in the first part of this report.

Although considerable success has been achieved in conservation and in other sponsored studies, coordination of the various energy efforts, resulting from the initiatives begun in the summer of 1979, should lead to greater success. A number of new specific plans (Basic Capability Development--BACADE--plans) have already been formulated. They are discussed in the latter part of this report. In view of the current personnel shortages at the PACMISTESTCEN, their implementation will depend to a great extent on manpower obtained from the Summer 1980 Student Engineering Program. However, if even a sizeable portion of the candidate studies being considered for the 1980 BACADE effort reach their objectives, a significant technological and/or financial benefit will accrue to the PACMISTESTCEN.

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## INTRODUCTION

Skyrocketing fossil fuel costs, double-digit inflation, and a growing vulnerability to curtailment of foreign oil and gas sources have combined to make the Navy's future energy supply uncertain. In 1977, the Navy recognized that "necessary steps must be taken to continually ensure the Navy's energy future, especially in the event of oil embargoes, limited wars, and limited interdiction of U.S. and Allied fuel supplies" (U.S. Navy Energy Office, 1977).<sup>1</sup> Since first priority on Navy supplies must go to Fleet ship and aircraft units, the energy pinch (both in terms of availability and cost) will be most severe on the Shore Establishment.

To offset these trends, a strong Energy Conservation Program and investigations of alternative energy systems have been initiated at Point Mugu.

The mission of the Pacific Missile Test Center (PACMISTESTCEN) is devoted to development and test and evaluation of missiles and weapon systems; it is a practical matter that the Center cannot expect to conduct all its work without adequate fuel supplies. Therefore, energy efforts must be considered compatible with the PACMISTESTCEN's mission and work.

Efforts have been initiated by the Scientific Advisory Board (SAB) and the Technical Director to develop basic capabilities (Basic Capabilities Development (BACADE) studies) of applying energy-saving technology to the needs of the PACMISTESTCEN. Since the pool of available manpower for established mission-related work is low, the BACADE efforts will rely on the Summer Engineering Program to supply manpower.

These efforts, along with the Energy Conservation Program and other energy-related studies, will be conducted to help achieve energy self-sufficiency at the PACMISTESTCEN. Point Mugu and San Nicolas Island (SNI) can be used as possible models of Navy sites in maritime and coastal environments. Emphasis will be placed on test and evaluation of alternative energy systems for such sites.

<sup>1</sup>U.S. Navy Energy Office (OP-413). U.S. Navy Energy Plan. Washington, D.C., USNEO, January 1977. UNCLASSIFIED.

## PARTIAL LIST OF PAST AND CONTINUING EFFORTS AT THE PACMISTESTCEN

A number of energy-related studies and efforts have been conducted at the PACMISTESTCEN and are continuing. These efforts have crossed a wide section of the Center's organization and involve people from different disciplines. Table 1 provides a list of those at the PACMISTESTCEN who have taken an active role, together with the areas in which they are or have been involved.

Following is a very brief description of some of these efforts and significant milestones.

### Significant Milestones in Alternative Energy Utilization Efforts

September 1976 - Dr. John Bond, Army Mobility Equipment Research and Development Command (MERADCOM), approached the PACMISTESTCEN for information to include in a study for Department of Defense (DOD) solar application sites. The PACMISTESTCEN, through Paul Erman, in the Ventures Programs Division, provided Dr. Bond with some data without MERADCOM funding. MERADCOM was unable to provide funding for this project, but referred NASA's Lewis Research Center (NASA Lewis) to the PACMISTESTCEN for solar research, development, and test and evaluation (RDT&E).

September 1976 - Mr. Erman offered the services of the PACMISTESTCEN to the Civil Engineering Laboratory (CEL) Energy Applications Branch Head, Mr. C. E. Parker. The Laboratory funded the PACMISTESTCEN to study solar reception and utility consumption on SNI. Results of this work were published by the Center as Technical Memorandum TM-76-15, Study of Solar Augmentation of Electrical Power at Pacific Missile Test Center Remote Island Sites, 30 December 1976, compiled by R. de Violini, Geophysics Division.<sup>2</sup>

1976-1977 - The CEL funded Mr. R. Helvey, PACMISTESTCEN Geophysics Division, to provide Laguna Peak wind data, to compile climatology of wind statistics, and to develop generalized computer software techniques for computing climatological statistics for evaluation of wind energy potential.

April 1977 - The CEL funded the PACMISTESTCEN, through Mr. P. Erman, to study alternative energy sources for naval bases. The results of this work were published by the Center as a Technical Memorandum TM-77-35, Model of

<sup>2</sup>Pacific Missile Test Center. Study of Solar Augmentation of Electrical Power at Pacific Missile Test Center Remote Island Sites, by R. de Violini, D. Crozier, and K. Lucci. Point Mugu, California, PACMISTESTCEN, 30 December 1976. (TM-76-15) UNCLASSIFIED.

Table 1. Energy Studies at the Pacific Missile Test Center, Principal Personnel and Focal Points.

Principal Personnel		
Energy Conservation Officer Energy Program Manager and Member, NAVAIR T&E Energy Council	CAPT M. M. Dallam ENS J. Power	(6200) Public Works Officer (6200-3) Energy Program Manager
Energy Program Consultant and BACADE Principal Investigator	J. Rosenthal	(3253) Geophysical Sciences Branch
Energy Project Engineering Manager and Point Mugu/SNI Test Manager	C. Elliott	(0141-2) General Technical Project Engineering Manager
Project Management Assistance	R. Warnagieris	(0160) Chief Engineer, Threat Sim., EW Project Office
	R. Unger	(0123) Ventures Program Division
	L. Maland	(0120) Plans and Programs Office
	P. Erman	(DP-2) Tomahawk Designated Project Office
Initiative, Direction, Ideas	T. Perry	(0002) Technical Director
	J. Rosenthal	(3253) Geophysical Sciences Branch
	R. Unger	(0120) Plans and Programs Office
	N. Van Slyke	(1230) Electromagnetic Systems Division
Senior Energy Coordinators	D. Burke	(1000) Systems Evaluation Directorate
	B. Wall	(2030) Fleet Weapons Engineering Directorate
	R. Rochon	(6010) Naval Air Station
	D. Power	(3000) Range Directorate
	R. de Violini	(3200) Range Operations Department
	D. Downey	(4000) Engineering Applications Directorate
	T. Randle	(0100) Project Management Group
	ATC E. Simmons	(VX-4) Air Test and Evaluation Squadron Four
	ENS B. Rafto	(NARU) Naval Air Reserve Forces
	C. Clark	(SPM) Naval Astronautics Group
	LT P. Pyle	(MAD) Marine Aviation Detachment
	LT Green	(VXE-6) Antarctic Development Squadron Six
Public Affairs	C. Lantrip	(0960) Public Affairs Office
	E. Waters	(0910) Administration Services Office
Studies		
Energy Conservation	ENS J. Power	(6200-3) Energy Program Manager
Photovoltaic and wind effectiveness models (including economics)	T. Trowbridge	(1230) Electromagnetic Systems Division
	D. Crozier	(1245) Weapons Effectiveness Branch
	E. Neuron	(3441) Project Coordination Branch
Systems design and loading characteristics, installation	K. Lucci	(3161) Support Systems Branch
	G. Trask	(6230) Engineering Division
	A. Mansi	(6230) Engineering Division
Climatic data and summarization (winds and solar insolation)	R. de Violini	(3253) Geophysical Sciences Branch
Solar variations and effects of atmospheric turbidity	T. Battalino	(3253) Geophysical Sciences Branch
Corrosion effects on solar panels	R. Stelhorn	(4240) Photographic Laboratories Division
Wind system efficiencies	T. Green	(3273) RF Communications Branch

the Economics of Alternative Energy Sources on Naval Bases: Report on Phase One Model, 31 October 1977, compiled by E. Neuron, Electromagnetic Systems Division.<sup>3</sup>

March 1978 - NASA Lewis funded the PACMISTESTCEN to install 12 photovoltaic cells on SNI for a several-year corrosion test.

13 March 1978 - A meeting was held to discuss Eric Neuron's beneficial suggestion for a solar study of SNI for energy independence. CAPT Weaver, CAPT Lewis, CAPT Reese, Mr. M. Miller, and ENS Shrewsbury agreed that the PACMISTESTCEN could not fund such a study, but agreed to offer SNI as a test site for future Navy solar research.

24 March 1978 - The COMPACMISTESTCEN forwarded a letter (Serial A-398)<sup>4</sup> to the Officer in Charge, CEL, providing further updating material for Technical Memorandum TM-76-15<sup>2</sup> and requesting that SNI be considered as a primary test site for Navy solar research.

13 April 1978 - The Naval Weapons Center/Civil Engineering Laboratory/Headquarters, Naval Material Command (NAVWPNCEN/CEL/NAVMAT) submitted a list to DOD (for Department of Energy DOE, consideration) of West Coast solar application sites for testing photovoltaic use. Several PACMISTESTCEN applications taken from TM-76-15<sup>2</sup> and from COMPACMISTESTCEN letter, serial A-398 of 24 March 1978,<sup>4</sup> were included in the list. Funding for these applications was to be made available from the Songus Amendment to the National Energy Act. The Songus Amendment was passed, and the Navy expected \$1 million by July or August for photovoltaic tests. As then stated, the National Energy Act was to provide \$6 to \$8 million over a 3 to 6-year period for the DOD. The NAVWPNCEN/CEL/NAVMAT have been preparing for this expected funding by updating the list of applications at 3 to 5-month intervals.

1977-1978 - The CEL conducted tests of a 5-kilowatt wind turbine generator on Laguna Peak and SNI. Strong winds and corrosion/mechanical problems limited its effectiveness.

<sup>2</sup>Pacific Missile Test Center. Study of Solar Augmentation of Electrical Power at Pacific Missile Test Center Remote Island Sites, by R. de Violini, D. Crozier, and K. Lucci. Point Mugu, California, PACMISTESTCEN, 30 December 1976. (TM-76-15) UNCLASSIFIED.

<sup>3</sup>Pacific Missile Test Center. Model of the Economics of Alternative Energy Sources on Naval Bases: Report on Phase One Model, by E. Neuron et al. Point Mugu, California, PACMISTESTCEN, 31 October 1977. (TM-77-35) UNCLASSIFIED.

<sup>4</sup>COMPACMISTESTCEN letter to Officer in Charge, CEL, Serial A-398 of 24 March 1978. Subj: Electrical Power Requirements for San Nicolas Island. UNCLASSIFIED.

1978 - Photovoltaic panels were used by the Geophysics Division at the Marine Environment Test Range, Site C, at SNI.

1979 - The PACMISTESTCEN's SAB sponsored talks on Solar Electrical Power Generation (Dr. Goodman, Southern California Edison) and on the Navy's Program in Photovoltaic and Wind Energy Applications (Dr. Watson and Mr. Pal, CEL). The SAB also cosponsored with the Energy Program Manager a talk on "Energy Perspectives - Today and Tomorrow" (Mr. John K. Cassell, Chevron, USA) as part of the Navy's Energy Awareness Week. Additionally, Dr. Edward Teller, of Stanford University's Hoover Institution on War, Revolution, and Peace, and Mr. Ralph Balent, Atomics International, discussed the use of nuclear power at separate meetings.

July 1979 - Mr. T. Perry, PACMISTESTCEN Technical Director, proposed a Command effort to develop and apply alternative energy systems at the Center.<sup>5</sup> The proposed program will rely heavily on summer employees.

August 1979 - The PACMISTESTCEN's Technical Director approved new BACADE initiatives and plans (provided by Mr. R. Unger, Project Management Group, and Mr. J. Rosenthal, Geophysics Division). These BACADE efforts were planned in the following areas:

- Lighting Intensity Study
- Heat Usage Study
- Laguna Peak Energy Study
- Solar Energy Study

#### Summary of Solar Collector Installations

(Prepared by LTJG J. M. Shrewsbury, Energy Program Manager, 1976 - 1977).

In 1974, the first collector was installed in Building 538. It was designed and built by Public Works, heats domestic hot water for the lavatory, and saves 6,668 cubic feet of natural gas a year.

Solar collectors were installed in 1975 on three office buildings at the Fleet Weapons Engineering Directorate, Oxnard Air Force Base, to heat domestic water for multiple lavatories. Each system was designed and built by Public Works at a cost of \$1,500 to \$1,800.

In 1976, a domestic hot water collector was installed on Building 506 for two lavatories. The purchased system cost \$1,700.

In 1977, Public Works installed its first solar space heating system for an office area in Building 537 at a cost of \$3,400. The system uses water as the heating medium and includes an electric backup.

<sup>5</sup>Pacific Missile Test Center Technical Director Memorandum, 0002, 12308, of July 1979. UNCLASSIFIED.

In 1977, the second space heating system was installed in the Meteorological Vertical Sounding Building, SNI. It uses air as the heating medium for the office and shop spaces. There are separate systems in the building for domestic hot water and space heating. Hot water is stored beneath the building for the space heating system, enabling it to provide heat for up to 2 days without sunlight. Total cost of the purchased systems was \$9,600. The building is planned to be available for operational use in 1980.

In 1978, discussions began within Public Works to convert Buildings 316 and 317 (missile support buildings) to solar heating.

#### Additional General Information on Solar Collectors

The installed collectors are of the highest quality, consisting of glass and copper with a life expectancy of at least 20 years.

Use of collector systems is economical if amortization can occur within the life of the collector. However, at the present time, it is generally more cost effective to use natural gas or fuel oil.

#### Energy Conservation Program

The PACMISTESTCEN has established an energy conservation program as an integral part of the attempt to reduce energy use and achieve energy self-sufficiency. The program was established in 1973 under the direction of the Public Works Department and is currently managed by ENS J. Power.

The following summary describes the scope and progress realized to date.

The PACMISTESTCEN has developed and is pursuing a highly successful energy conservation program. Efforts to reduce energy consumption include engineering retrofits, facility maintenance, personnel awareness, conservation studies, and Energy Conservation Investment Program (ECIP) project planning (portion of MILCON). Figure 1 shows the expected results of energy conservation when the official FY-75 is used as a baseline. When FY-73 is used as a baseline, however, the PACMISTESTCEN actually achieved the utility energy reductions (shown in table 2), which are based on energy consumed per square foot of floor area.

Engineering retrofits and maintenance efforts include:

1. Installing power system capacitors;
2. Rerouting power loads for electrical efficiency;
3. Specifying fewer and lower wattage bulbs (150,000 watts of lighting load were disconnected in 1973 - 1974);

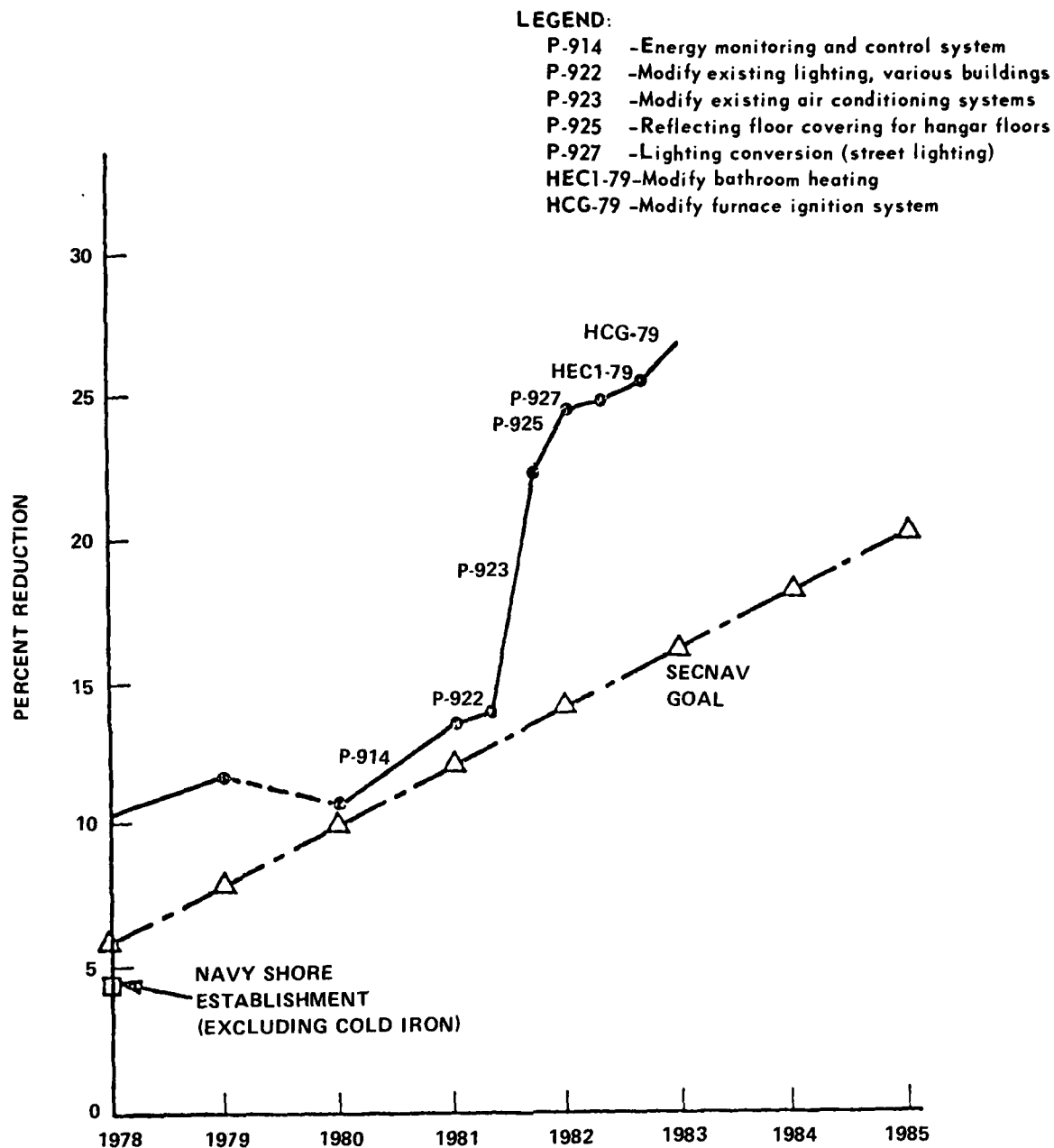


Figure 1. Expected Results of Energy Conservation Investment Program/Housing Conservation Projects When FY-75 Is Used as a Baseline.



Table 2. Utility Energy Reduction, FY-73 Baseline.

Fiscal Year	Energy Reduction (Percentage)	Total Cost Increase (Percentage)	Unit Cost Increase (Percentage)
1974	21.2	21.8	54.6
1975	17.2	59.2	92.3
1976	24.0	48.0	94.8
1977	28.7	88.2	123.8
1978	30.0	134.8	192.6
1979	26.9	155.7	212.9

4. Specifying insulation on all building and piping modifications;
5. Installing controls to optimize heating, lighting, and air-conditioning systems;
6. Using 8 to 10 solar collectors and a windmill to pump water at SNI;
7. Securing boilers during warmer months and cleaning tubes for efficiency;
8. Reducing boiler and water heater temperatures;
9. Installing toilet dams and low-flow shower heads to save water;
10. Having SARCO, Inc., conduct a steamtrap survey;
11. Insulating seven shop buildings;
12. Eliminating heating in open bay areas;
13. Installing a fuel oil distribution system;
14. Controlling electric heater use;
15. Installing energy-efficient equipment.

Personnel awareness program includes:

1. Using "The Missile," Plan of the Day, and bulletin boards for publicity, conservation hints, and articles;
2. Distributing letters and posters encouraging conservation;
3. Scheduling of programs, speakers, and displays;
4. Holding training sessions for conservation techniques;
5. Constructing bicycle paths;
6. Spot checking for compliance with heating, lighting, and air-conditioning standards;
7. Establishing the Transportation Review Board;
8. Establishing a carpool program;
9. Conducting the annual Energy Awareness Week program;
10. Enforcing the Christmas lighting policy.

Conservation studies in progress or planned include:

1. Energy self-sufficiency study at SNI sponsored by the CEL;
2. Science Applications, Inc., study of energy-use habits of family housing residents;
3. Public Works comprehensive base-lighting survey;
4. Mitchell-Webb, Inc., study of air conditioning systems above 50 tons;
5. Study of utility distribution systems and operation of boilers;
6. Infrared flyover survey;
7. Comprehensive energy use survey of Building 761;
8. BACADE studies;
9. Establishment of Electrical Consumption Distribution System;
10. Installation of tamper-proof thermostats;
11. Study of potential solar applications.

Conservation projects planned include:

1. Seven ECIP projects, with total estimated energy savings of 15 percent;
2. Consolidation of compressed air and 400-hertz generator systems;
3. Utilization of summer engineers to program use of alternative energy resources at the PACMISTESTCEN;
4. Replacement of inefficient centralized boiler with efficient separate boilers on SNI;
5. Integration of low-pressure air systems;
6. Installation of capacitors at SNI;
7. Provision of solar heating at the SNI Bachelor Officers' Quarters;
8. Reinsulation of heating and ventilation ducts.

The PACMISTESTCEN's conservation program is effective, resulting in several awards, including the SECNAV Award for 1973 - 1977.

### Real-Time Endurance Solar Cell Modules Tests

Under the former sponsorship of NASA's Lewis Research Center and now that of the Jet Propulsion Laboratory, an array of solar panels has been mounted adjacent to the SNI Marine Environment Test Range to determine and document the rapidity with which corrosion occurs in a marine environment. Monthly inspection reports are prepared by Richard Stelhorn at SNI and forwarded to the sponsors. Figures 2 and 3 show the location and arrangement of the solar panel array.

### Economic Tradeoffs of Alternative Energy Systems for Navy Use

Under the sponsorship of the CEL, a series of models is being developed by T. Trowbridge, D. Crozier, and E. Neuron to determine the relative cost-effectiveness of various energy options in the Navy. Efforts are focused on the prospects of solar and wind energy systems that might be employed to supplement energy requirements at SNI. Economic tradeoffs are being investigated with the use of solar insolation and wind data provided by the Geophysics Division. Early progress was documented in TM-77-35 by Neuron et al.<sup>3</sup> and by Trowbridge (1977).<sup>6</sup> Additional progress reports are currently in preparation. The plans are to expand energy considerations to other source types (solar space and water heating, cogeneration, refuse, wave power) in FY-80 and study their application to Point Mugu in addition to SNI.

### Solar Augmentation Study at Remote Sites

In 1976, under the sponsorship of the CEL with technical guidance from the MERADCOM, a study was conducted to determine the potential of individual PACMISTESTCEN remote sites for supplementing with or converting to photovoltaic energy systems. Solar radiation measurements were made at SNI and used with longer term data bases from Point Mugu (Geophysics Division) to develop algorithms for estimating seasonal characteristics of radiation conditions at SNI. Models were developed and energy loading at several sites was summarized to determine potential candidates for photovoltaic conversion. The work was summarized by R. de Violini, D. Crozier, and K. Lucci in TM-76-15.<sup>2</sup>

<sup>2</sup>Pacific Missile Test Center. Study of Solar Augmentation of Electrical Power at Pacific Missile Test Center Remote Island Sites, by R. de Violini, D. Crozier, and K. Lucci. Point Mugu, California, PACMISTESTCEN, 30 December 1976. (TM-76-15) UNCLASSIFIED.

<sup>3</sup>Pacific Missile Test Center. Model of the Economics of Alternative Energy Sources on Naval Bases: Report on Phase One Model, by E. Neuron et al. Point Mugu, California, PACMISTESTCEN, 31 October 1977. (TM-77-35) UNCLASSIFIED.

<sup>6</sup>Pacific Missile Test Center. "Economics Model," Appendix A, of Model of the Economics of Alternative Energy Sources on Naval Bases: Part Two, Wind Turbine and Photovoltaic Electrical Power on San Nicolas Island, by T. S. Trowbridge. Point Mugu, California, PACMISTESTCEN, 29 September 1977. (Manuscript in preparation) UNCLASSIFIED.



Figure 2. Solar Panel Array.

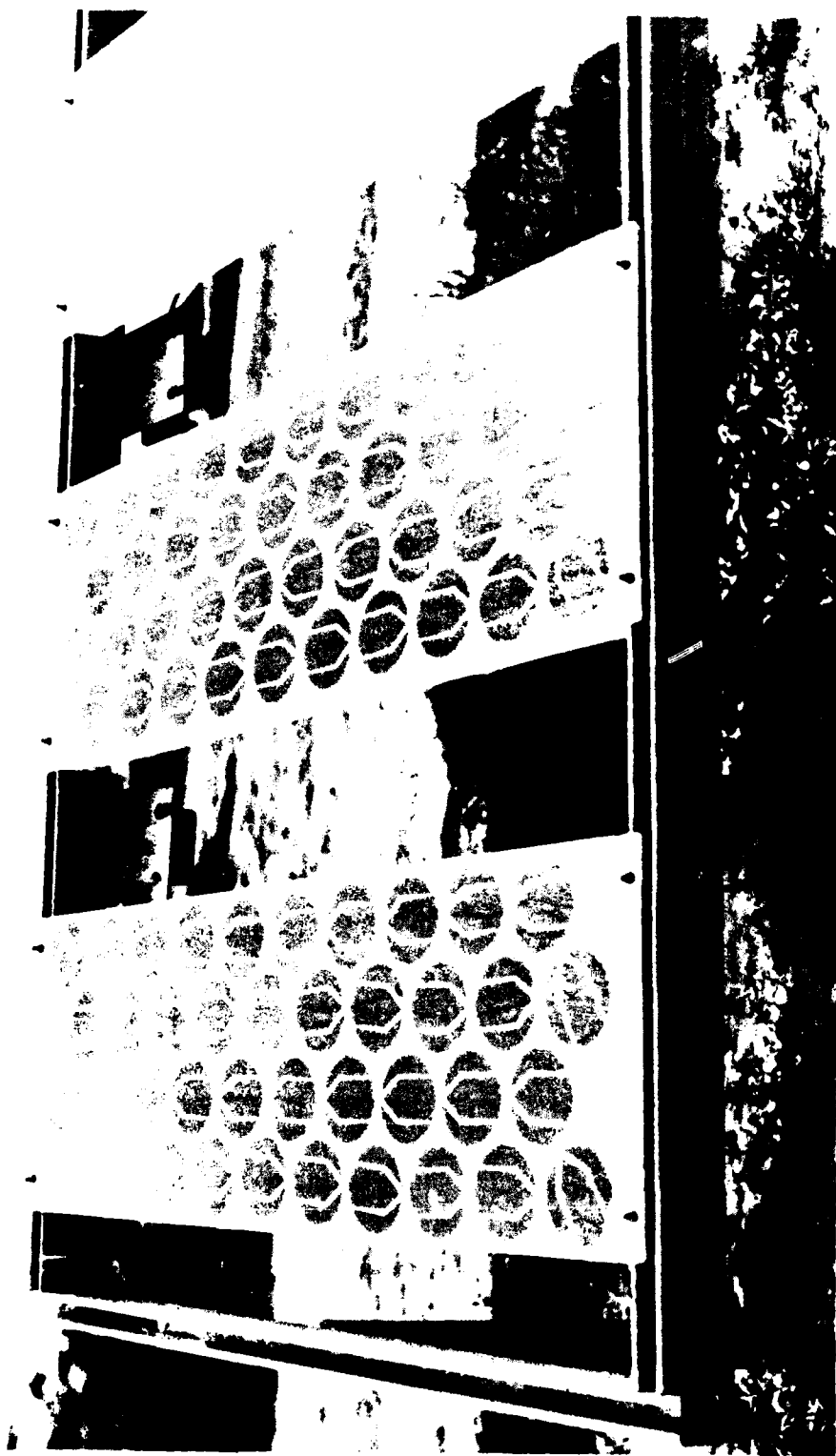


Figure 3. Close-Up View of Solar Panels.

### Wind Turbines

In 1977, Mr. D. Pal of the CEL installed a 5-kilowatt wind turbine on Laguna Peak with the assistance of Mr. A. Mansi of the PACMISTESTCEN Public Works Department. During the period of testing, several episodes of very strong winds caused mechanical failure of the system (figures 4 and 5). Similar mechanical problems were encountered during field testing at SNI. Such mechanical defects or limitation were common to these early systems. Specific details on this 5-kilowatt field demonstration are provided in table 3 (from Pal, 1979, and Pal, 1977).<sup>7,8</sup> Better design and more sophisticated instrumentation make wind turbines a more attractive possibility today than those models of even a few years ago.

### Energy Tips

As part of the Command's Energy Conservation Program, Mr. D. Downey, Engineering Applications Directorate Representative has initiated a simple and innovative procedure for disseminating energy news and related information. Through the use of periodic one-sheet newsletters and cartoons, he has increased energy-awareness within his directorate. Figure 6 provides an example of his unique contributions to the PACMISTESTCEN's efforts. In addition, conservation tips are disseminated through "The Missile," Plan of the Day, and brochures sent to base housing residents.

### Formulation of Coordinated Plans

In July 1979, Mr. T. Perry, PACMISTESTCEN Technical Director, requested that initiatives be undertaken to develop long-term solutions to the Center's anticipated energy limitations. Mr. J. Rosenthal was tasked to develop a general plan by which coordinated progress could begin in late FY-79 and progress into the 80s through the use of Summer Engineering student employees as a valuable source of support.

A slightly modified version of this preliminary plan as outlined on 30 July is provided in appendix A.

Following preparation of this tentative proposal, several meetings were held to discuss the scope of the plan, particularly in light of the PACMISTESTCEN's shortage of personnel. It was decided to limit involvement mainly to what could be accomplished with summer employees and a limited amount of professional assistance plus those energy conservation and continuing sponsored studies previously described. It was also agreed that to

<sup>7</sup>Pal, D. Navy Wind Energy Program. Presented to the PACMISTESTCEN in a program sponsored by the Scientific Advisory Board, 13 September 1979.

<sup>8</sup>Civil Engineering Laboratory, Naval Construction Battalion Center. Wind-Generated Electric Power at Navy Sites, by D. Pal. Port Hueneme, California, CEL, June 1977. (CEL TN-1485) UNCLASSIFIED.

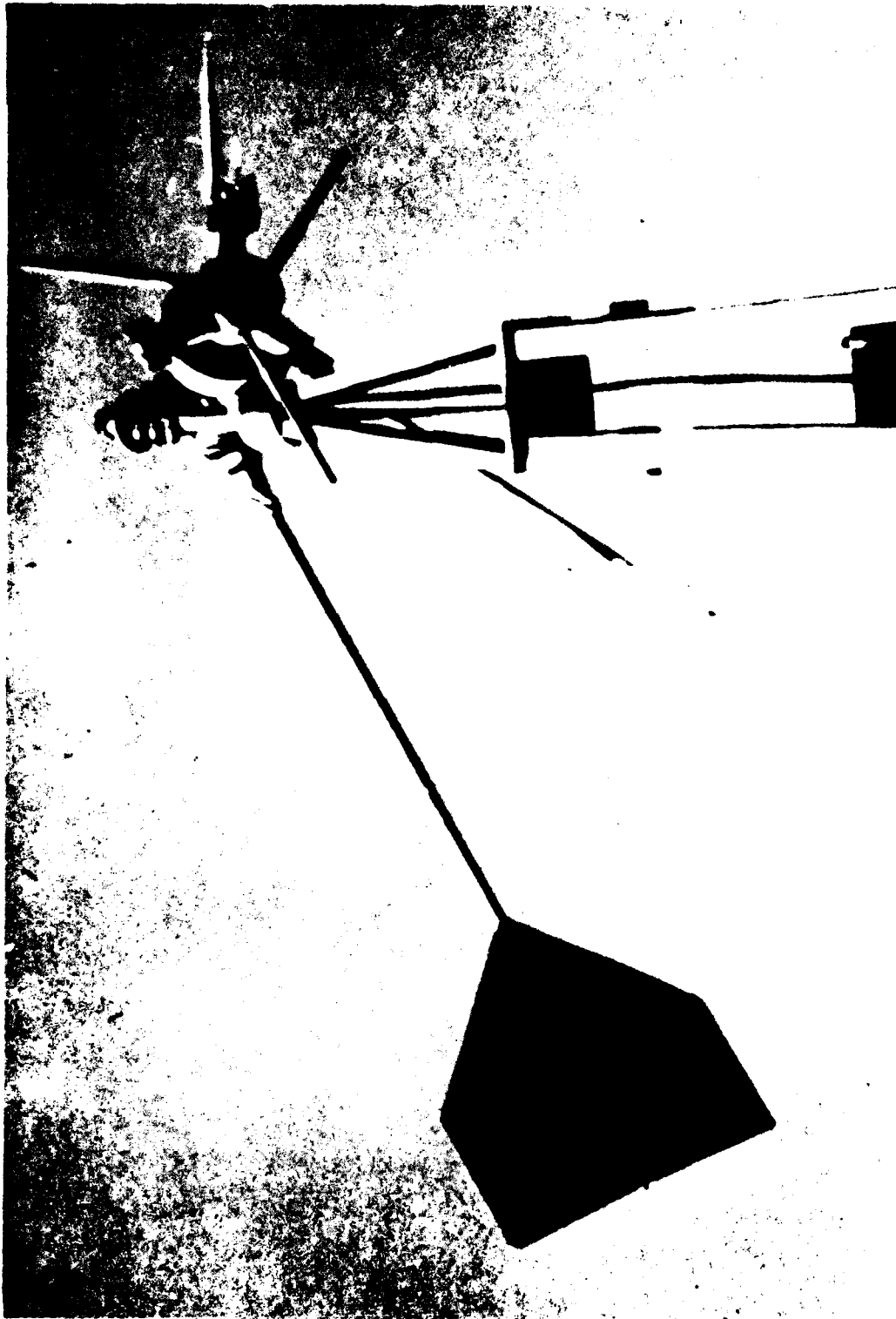
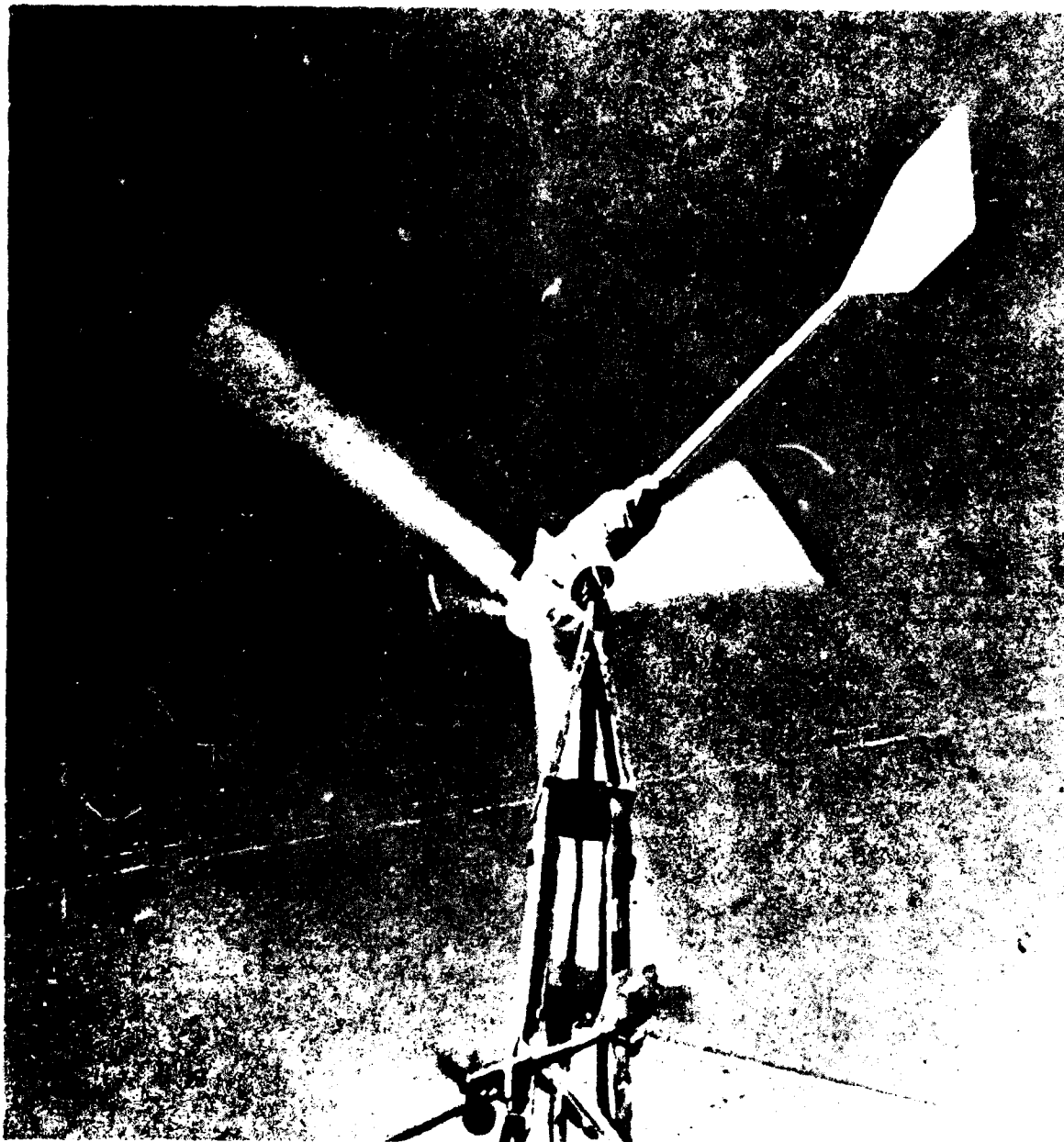


Figure 4. The 5-Kilowatt Wind Generator Test Installation at Laguna Peak After a Sudden Failure.





*Figure 5. Demonstration of the 5-Kilowatt Wind Turbine Generator at San Nicolas Island.*

Table 3. Specific Details on the 5 Kilowatt Field Demonstration at San Nicolas Island.

#### **SITE CHARACTERISTICS**

ANNUAL AVERAGE WIND SPEED = 11.1 MPH

AVERAGE POWER AVAILABLE IN THE WIND  
PER UNIT DISK AREA OF THE ROTOR = 14.0 WATTS/FT<sup>2</sup>

CORRELATION BETWEEN AVAILABLE WIND  
POWER WITH LOAD DEMAND = A GOOD SEASONAL AND DIURNAL

#### **WIND TURBINE GENERATOR**

PROPELLER DIAMETER = 16.3 FT

OUTPUT = 5 KWe AT 24 MPH WIND SPEED

TYPE OF GENERATOR = 3 PHASE WITH A SELF EXCITED ALTERNATOR

ESTIMATED ANNUAL OUTPUT  
OF THE SYSTEM SNI = 15,800 KWHRS

#### **POWER CONDITIONING**

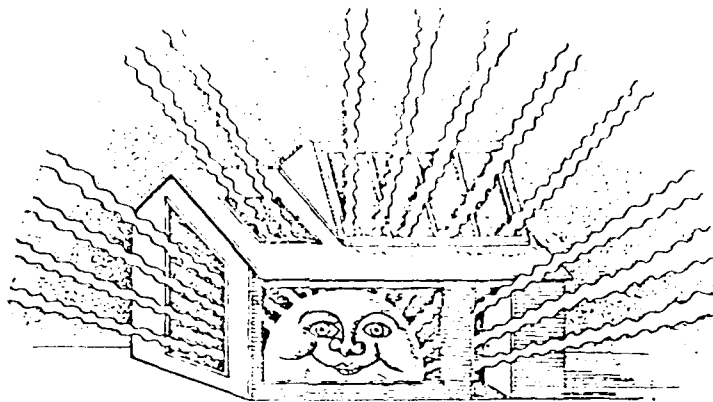
CEL LOAD MATCHING SYSTEM

#### **TYPE OF LOADS**

ELECTRIC RESISTANCE  
SPACE HEATER

**PRESENT STATUS:** THE WTG ASSEMBLED AFTER CORRECTING TURNTABLE YAWING PIN FAILURE

(from Pal, 1979)



## ABOUT ENERGY

WE HAVE BEEN TOLD THAT IT WILL BE MANDATORY THAT BY 1985 WE REDUCE OUR ANNUAL ENERGY CONSUMPTION BY 20% FROM WHATEVER OUR CONSUMPTION WAS IN 1975.

SO FAR WE ARE AROUND 11% AND WE REACHED THAT IN 1978, THEN LEVELLED OFF THIS YEAR. THIS MEANS IT WILL TAKE A BETTER AND HARDER EFFORT EACH YEAR FROM NOW ON TO REACH THIS GOAL.

A TIGHTER EFFORT BY EACH INDIVIDUAL THROUGHOUT THE ENTIRE WORKFORCE WILL BE NECESSARY. THIS WOULD ALSO MEAN A SIGNIFICANT SAVINGS IN DOLLARS TOO.

SO FAR, EAD HAS BEEN A LEADER IN THIS EFFORT AND WE HOPE YOU WILL CONTINUE TO DO SO.

LET'S TRY TO PINPOINT ENERGY LOSSES PERHAPS OVERLOOKED BEFORE.

MANY PERSONS GO TO SLEEP AT NIGHT PONDERING TWO QUESTIONS - ONE IS, WHAT WILL HAPPEN TO THEIR IMMORTAL SOUL, AND THE OTHER IS WILL I BE ABLE TO GET GAS FOR MY CAR IN THE MORNING?

D. DOWNEY  
EAD ENERGY REPRESENTATIVE  
CODE 4015

*Figure 6. Example of Engineering Applications Directorate Energy Newsletter.*

the greatest extent possible, the technical guidance, expertise, and systems developed by the Energy Program Office at the CEL would be used. The PACMISTESTCEN's unique contributions can probably be made in serving as a model coastal/maritime site for the test and evaluation of Navy alternative energy systems and for the adaptation and application of those systems to the needs of the PACMISTESTCEN.

In order to initiate some specific task areas in FY-79, four separate efforts with very modest funding were suggested by Mr. R. Unger, Project Management Group, and approved as BACADE projects, with Mr. Rosenthal identified as responsible individual. These are briefly described in table 4.

#### Determination of Parameters for Storage Battery Systems

This BACADE project was managed by Mr. T. Trowbridge. It involved the computation of storage requirements for various excess capacities in order to maintain a given amount of reliable average output. Studies are being conducted for storage systems involving both photovoltaic and wind generating systems.

#### Procurement of Solar Insolation Equipment

Pyranometers have been procured for use in radiance studies at the Marine Environment Test Range on SNI. When available, they will also be of significant value in developing data bases for application to energy studies at SNI.

#### Ideas Generated by Summer Employees

In response to a request from the Technical Director, several ideas were generated by engineering students employed by the PACMISTESTCEN during the summer, 1979. A few of the suggestions received are included as appendix B.

#### Use of Windmill to Pump Water at San Nicolas Island

A windmill has been procured and installed to pump approximately 5,000 gallons of spring water per day to a tank in the distribution system. Use of this water will lessen dependence on the energy-intensive desalinization plant.

#### Construction of Bicycle Paths

An initial project has been completed to construct bicycle paths on Frontage Road from the Government property line to Mugu Road. The paths, 4 feet wide, run on both sides of the 2,000-foot stretch and are clearly designated as bicycle paths.

Table 4. FY-79 Initial BACADE Projects.

Project	Progress
<p><u>Lighting Intensity Study - \$4,500</u></p> <p>Make a lighting-intensity survey and study of all occupied spaces at the PACMISTESTCEN and SNI with the objective of reducing unnecessary light bulbs and fixtures. Use light meters (now on hand) positioned at bench, floor, or other working levels and record observed values. Compare with NAVFAC lighting criteria for that occupancy.</p> <p><u>Heat Use Survey, SNI - \$3,000</u></p> <p>Make a heat-use survey of spaces at SNI to determine where and why heat is being lost and how losses can be prevented, so that heat loss from buildings on SNI and elsewhere at the PACMISTESTCEN can be minimized and more effective use made of heating supplies. Make recommendations for revised operating modes and procedures.</p> <p><u>Comprehensive Survey Study, Laguna Peak - \$3,000</u></p> <p>Make a comprehensive, engineering study of the use of all types of energy at Laguna Peak in order to plan and manage electrical energy consumption more effectively and to reclaim and use waste heat from the uninterruptible power supply (UPS) system and the air conditioning system for hot water and space heating. Investigate in depth the potential for using the waste heat thrown off by the eddy-current clutch of the UPS unit.</p> <p><u>Solar Heating Domestic Water at SNI and Point Mugu - \$3,000</u></p> <p>Make an engineering investigation and study to determine the feasibility, costs, and benefits of installing solar heating systems for domestic water in all buildings at SNI and Point Mugu. Include schematic designs and estimated costs for each typical installation, together with ample design criteria for making final engineering drawings and specifications.</p>	<p>A base-wide effort to accrue significant energy savings has been planned by Public Works. Feasibility of the study was established by an initial survey of several buildings.</p> <p>Although Public Works has initiated plans to conduct such a survey, the limited manpower available might better be committed to other energy initiatives.</p> <p>Public Works is considering negotiating a contract under which some of this work might be accomplished.</p> <p>There is agreement on the feasibility of solar water heaters, but disagreement as to the necessity for hot water. Until the questions that have arisen are resolved, most of this effort is being redirected into other aspects of solar technology and their potential impact on the PACMISTESTCEN.</p>

### NAVAIRSYSCOM Test and Evaluation Energy Council

An organizational meeting of the NAVAIRSYSCOM Council was held during the week of 17 September 1979. ENSIGN C. Savant, PACMISTESTCEN member, attended this meeting. The purpose of the Council is to stimulate conservation awareness and to recommend firm energy conservation measures throughout the NAVAIRSYSCOM test and evaluation establishment. Included is the planned training of effective energy managers. In order to achieve these objectives, the Council will visit each field activity and make recommendations for a more effective program. In addition, funding plans were made for energy-conservation training of PACMISTESTCEN personnel in FY-80. This initial planning meeting was favorably received within NAVAIRSYSCOM and received the support and encouragement of the Chief of Naval Operations (Logistics).

The NAVAIRSYSCOM Council effort is one direct way to implement Energy Management directives ordered by NAVMAT Instruction 4100.16A of 12 October 1979.<sup>9</sup> This instruction requires that NAVAIRSYSCOM act for NAVMAT to plan, control, and coordinate aircraft energy matters including (a) providing technical criteria and engineering expertise to assist Navy aircraft in meeting the Navy's energy goals, (b) to validate energy consumption reports, (c) to develop a systems engineering approach and timetable for improving the efficiency of Naval aircraft systems, (d) to develop and execute a specific research and development program for aircraft energy conservation and alternative energy sources, (e) to develop aircraft simulators and techniques to reduce energy consumption, and (f) to develop and execute a program to implement and document energy RDT&E projects.

The NAVAIRSYSCOM Test and Evaluation Energy Council met again from 28 January through 1 February 1980, with the PACMISTESTCEN serving as host on 28 - 30 January. Attendees included the following:

Council Chairman  
Mr. Robert Samchisen (AIR-6103E)

Mr. G. Smith	Naval Weapons Center, China Lake, CA
LCDR A. Corsana	Naval Air Propulsion Center, Trenton, NJ
Mr. H. Dorkin	Atlantic Undersea Test and Evaluation Center, Andros Island, Bahamas
LCDR T. Rampe	Naval Avionics Center, Indianapolis, IN
Mr. J. Gardner	Naval Air Engineering Center, Lakehurst, NJ
Mr. B. Russell	Naval Air Station, Patuxent River, MD
ENS C. Savant	Pacific Missile Test Center, Point Mugu, CA

In addition, Mr. Jay Rosenthal, PACMISTESTCEN (Code 3253), attended as PACMISTESTCEN's Prime Alternate Energy Source Investigator. Captain M. Dallam, Energy Conservation Officer, also attended the meeting.

<sup>9</sup>NAVMATINST 4100.16A of 12 October 1979. Energy Program Management. UNCLASSIFIED.

Highlights included an overview presentation of the PACMISTESTCEN by Mr. R. Warnagieris, Acting Associate Project Management Group Officer; a tour of selected PACMISTESTCEN work areas; and an afternoon visit to the CEL and Navy Environmental Support Office at Port Hueneme.

After leaving the PACMISTESTCEN, the Council traveled to NWC, China Lake, for a continuation of discussions.

The following items summarize actions taken at the NAVAIRSYSCOM Council meeting:

1. Discussions were held on increasing the FY-81 budget and developing plans for energy-conservation projects for facilities and operations.
2. Energy-performance statistics for FY-79 were discussed. The PACMISTESTCEN led NAVAIR-06 activities with a 12.4-percent reduction below the FY-75 baseline.
3. Mr. Robert Samchisen informed the Council that a NAVAIR Energy Steering Committee, chaired by AIR-01A, has been formed to consider energy policies.
4. Mr. Samchisen will prepare a charter for the Council.
5. The Council budget will be modified to provide approximately \$6,000 to the PACMISTESTCEN in FY-80 and \$40,000 in FY-81 for equipment, studies, and projects, and \$5,000 in FY-80 and \$7,000 in FY-81 for energy-related training.
6. The Council toured several PACMISTESTCEN facilities and concluded that the operational use of energy should be considered in order to achieve greater energy reductions.
7. The Council recommended that NAVAIR instruct each activity to:
  - a. Submit a comprehensive plan to achieve energy conservation goals to be established for each activity.
  - b. Establish a permanent billet for energy conservation.
  - c. Consider suspension of normal operations during the Christmas holidays.
  - d. Continue compliance with DOE Emergency Building Temperature Restrictions.

- e. Emphasize energy conservation training for base employees.
- f. Include energy conservation goals in the Merit Pay System.
- g. Consider hiring summer students for energy conservation projects and studies.
- h. Prepare a facility consolidation plan where feasible for energy conservation.



## BACADE PLANS AND RECOMMENDATIONS FOR FY-80

As a result of this energy project, a large number of overlapping ideas and initiatives have been generated or suggested since July 1979. One goal of this FY-79 effort was to stimulate thinking toward energy conservation and alternative energy sources. As a result of several meetings and discussions, the following recommendations are offered as modest but realistic candidates for consideration in FY-80 in behalf of PACMISTESTCEN's energy well-being. These are in addition to the existing PACMIST. TCEN Energy Conservation Program and other ongoing energy-related studies under sponsorship of the CEL and of NASA/Jet Propulsion Laboratory. Resource requirements for each effort are estimated when possible, and the anticipated primary areas of responsibility are indicated in parenthesis. It is anticipated that approval of BACADE funding in FY-80 would permit at least some of these to be started.

### Comprehensive Lighting Survey (Public Works Department)

This effort will be a continuation of the effort begun before FY-79 and will involve identification of lights that can be removed in many buildings with assistance of Energy or Facility Managers. Lights will be tagged and the bulbs removed by Public Works personnel. One building at a time will be worked on. The Public Works coordinator will tally lights removed. Preliminary estimates are that potential savings of up to \$2,000 per building per year can be realized. Anticipated requirements are two Public Works personnel and funds of approximately \$12,000. One summer employee will also be required. Public Works critical manpower shortages may deter widespread implementation of this survey. Maximum utilization of Facility and Energy Managers could partially alleviate the problem.

### Solar Energy Study (Public Works Department)

The purpose of this study is to evaluate the feasibility of using solar systems for space and hot water heating. The approach taken will be to determine hot water requirements for buildings and calculate optimum design specifications, considering weather data, storage capacity, collector efficiency, water temperature, and cost. The CEL Technical Report R835 "Solar Heating of Buildings and Domestic Hot Water" of January 1976 by E. J. Beck, Jr., and R. L. Field<sup>10</sup> will provide assistance in preparing the analysis. Two summer engineers will be required for this project.

<sup>10</sup>Civil Engineering Laboratory, Naval Construction Battalion Center. Solar Heating of Buildings and Domestic Hot Water, by E. J. Beck, Jr., and R. L. Field. Port Hueneme, California, CEL, January 1976. (Technical Report CEL-TR-835) UNCLASSIFIED.

#### Wind Siting Study on San Nicolas Island (Geophysics Division and Others)

The CEL is interested in the possibility of locating a large (100 kilowatt) wind generator system at SNI as a major future test of wind energy applications. In addition to funding identification for such a project, a prerequisite is a satisfactory wind-siting study (2 years) to determine an optimum location on SNI. The CEL has indicated the desirability of establishing 15 wind-observation sites to be measured by three portable meteorological stations. In addition to the identification of outside funds, a requirement would exist for a full-time technician to maintain sensors and recorders. This would necessitate a new technician billet in Geophysics. In the meantime, a reasonable approach is to perform statistical evaluation of wind data obtained from several sites at the Marine Environment Test Range on northern SNI. Resources required for this initial phase will be approximately 2 man-months plus computer time or approximately \$5,000. This can be accomplished with one summer employee using BACADE funds. It should be noted that preliminary results of economic studies conducted by Mr. T. Trowbridge indicate that wind turbines would be cost-effective at SNI.

#### Wind Study Applications (Public Works Department, Electromagnetics Division Geophysics Division, Civil Engineering Laboratory)

With the use of data obtained from the above study, correlations can be performed between environmental data, wind generator specifications and efficiencies, and economic analyses to determine the cost-effectiveness of wind systems. Resources required might be approximately \$10,000 plus manpower.

#### Solar Radiation Study on San Nicolas Island (Geophysics Division, Electromagnetics Division, Weapons Systems Division)

The CEL is also interested in the feasibility of locating a large (100 kilowatt) photovoltaic system at SNI for testing and tying into the established power grid. As in the case with the large wind generator device, a prerequisite is the carrying out of a meaningful study of actual radiation conditions at the island. Pyranometers that have been procured by Geophysics Division personnel for use at the Marine Environment Test Range could be used for part of such a study. Statistics could be derived for horizontally placed and inclined sensors as a function of weather and season. The influence of scattering due to aerosols and its impact on solar spectral intensity in a marine environment should also be addressed. Resources required for this study include one summer employee, computer time, professional and technician assistance, and approximately \$12,000. The data collected will allow real measurements to be used in cost-effectiveness studies instead of approximate modeled data, as was the case in earlier studies. (NOTE: The Mount Laguna Air Force Station has a 60-kilowatt photovoltaic system that covers half an acre and cost \$1,600,000 in 1977.)

#### Laguna Peak - Heat Recovery Study (Public Works Department)

This study would be a continuation of the effort begun in FY-79. It would involve efforts to recover heat from the UPS clutch unit and reapply it to water and space heating requirements.

#### Planning (Project Management, Geophysics Division, Public Works Department, Others)

This will be a low-key but continuous effort requiring formulation of plans, coordination, supervision, direction, compilation of ideas, visits to established field sites, management, establishment of a library of energy information, etc. It would require one summer employee, various professional assistance, and approximately \$15,000, including \$3,000 for travel.

#### Fog Drip Study (Geophysics Division)

Attempts could be made to collect and study water resources on SNI obtained by fog drip. Fog drip occurs when wind-blown fog droplets impact and run off from surfaces exposed to the airflow. On windy, foggy SNI, where fresh water is at a premium, this could be a significant source. Resources required include one summer employee and approximately \$8,000.

#### Energy Awareness Week Programs (Public Works Department, Scientific Advisory Board Speakers Committee)

(This item has already been accomplished for FY-80.) The Energy Conservation Board plans an annual program to promote conservation awareness among PACMISTESTCEN employees. The FY-80 program included a DOE-sponsored workshop, training sessions, displays, dissemination of literature, movies, and a talk to all hands by Mr. John Cassell of Chevron USA. This talk was jointly sponsored by the SAB and the Energy Conservation Board.

#### Federal Photovoltaic Utilization Program (FPUP)

Under Phase I of the FPUP, the PACMISTESTCEN is a planned site for the DOE-funding Navy applications of photovoltaic systems. It is planned to install three small units to operate buoy lights in PACMISTESTCEN target areas.

#### Conservation in New Construction

It is suggested that new construction projects designed in FY-80 and beyond consider use of skylights, solar panels, heat-recovery techniques, high-pressure sodium lights, time clocks, and other controls and equipment in order to meet the 45-percent energy reduction goal for new facilities compared to the 1975 baseline.

#### Pacific Missile Test Center Energy Projects Program Reviews

It is suggested that two program reviews per year be scheduled, in January and June, to coordinate and evaluate PACMISTESTCEN Energy Projects.

#### Pacific Missile Range Facility (PACMISRANFAC) Applications

A preliminary feasibility study should be made to determine the suitability of PACMISRANFAC sites for testing and application of solar, wind, and other alternative energy sources. (This effort would require considerable manpower assistance from the Facility.)

#### BACADE APPROVAL

On 11 January 1980, the Technical Director approved an FY-80 BACADE Project titled, "Energy Program for PACMISTESTCEN," with Mr. J. Rosenthal designated Principal Investigator. Its purpose is to make use of the talents of summer engineering students to perform some of the energy-related tasks outlined in the previous paragraphs in the areas of energy conservation, monitoring, climatological studies, and the investigation of alternative energy source applications to the PACMISTESTCEN. The BACADE effort authorizes a total of \$27,300 for labor, materials, and related travel.

Preliminary plans call for the work to be performed principally by eight summer employees: four assigned to Public Works, two assigned to the Geophysics Division, and two assigned to the Project Management Group.

## PACIFIC MISSILE TEST CENTER ENERGY PROGRAM

The success of a strong energy program requires the close cooperation of several Directorates and line organizations under the directorship of the Energy Conservation Officer in order to implement a coordinated energy program within present personnel constraints. To strengthen such cross-organizational coordination, and as indication of strong Command interest in energy awareness, Thad Perry, Technical Director, on 14 May 1980, assigned the following responsibilities:

Energy Conservation Officer - CAPTAIN M. M. Dallam (Code 6200). Responsible for monitoring the effectiveness of the energy conservation program and ensuring coordination between Directorates and Tenants in energy-related matters.

Energy Program Manager and Member, Naval Air Systems Command Test and Evaluation Energy Council - ENSIGN J. Power (Code 6200-3). Responsible for serving as single point of contact for energy-related matters and coordinating energy conservation initiatives.

Energy Project Engineering Manager and Point Mugu/San Nicolas Island Test Manager - Mr. C. Elliott (Code 0140). Responsible for serving as Manager and Coordinator of sponsored energy projects, including those involving testing of energy-related devices, and for serving as energy focal point within the Project Management Group.

Energy Program Consultant - Mr. J. Rosenthal (Code 3253). Responsible for providing initiative in energy applications at the PACMISTESTCEN, particularly alternative energy sources, and for providing technical guidance on energy matters related to the natural environment.

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APPENDIX A  
PRELIMINARY PROGRAM OUTLINE FOR DEVELOPMENT  
OF ALTERNATIVE ENERGY SOURCES AT THE PACMISTESTCEN  
30 JULY 1979

1. OBJECTIVES

a. Develop a program leading to the operational exploitation of alternative energy sources at PACMISTESTCEN.

b. Develop the basis, guidelines and technology for efficient use of alternative energy sources at Navy coastal and maritime activities using PACMISTESTCEN as a model.

c. Investigate impact of energy conservation on PACMISTESTCEN energy utilization.

2. GENERAL APPROACH

Ideas for potential alternative energy projects will be collected and consolidated using principally summer student employees. These ideas will be reviewed from the standpoint of practicality, feasibility, cost-effectiveness and their relation to other ongoing efforts within the Federal government, state and local government, universities, the local community and private industry. All PACMISTESTCEN efforts will be closely coordinated with the above communities. Climatological and other environmental studies will be conducted to form a basis for determining feasibility and cost-effectiveness. It is intended to use and feed on present and prior PACMISTESTCEN investigations on energy alternatives including work sponsored by CEL and MERADCOM. Based on plans formulated, prototypes of PACMISTESTCEN systems will be designed, developed or adapted when available. They will, when possible, first be tested in environmental chambers and later, for prolonged periods at PACMISTESTCEN sites at Point Mugu, SNI, Barking Sands, or on nearby remote mountain/island locations where they may demonstrate real energy contribution and operational utility. Applications will be devised for PACMISTESTCEN and recommendations made for implementations elsewhere at Navy coastal activities. When possible, attempts will be made to acquire Navy and DOD support of PACMISTESTCEN efforts.

3. BACKGROUND

The current energy crisis will result in an economic drain on PACMISTESTCEN and the Navy in performance of its mission. The ability of PACMISTESTCEN to perform its mission will be further compromised by the near total dependence on oil and gas for energy. Since the first oil crisis in 1973, a



number of efforts have been initiated at PACMISTESTCEN in search of other energy alternatives. Among these are climatological, economic modeling, insolation measurement, testing of windmills and solar panels and other studies performed by Geophysics, Systems Engineering Directorate, Project Management Group, Capabilities Development Department (CDD), and Public Works personnel in support of consideration of alternative energy sources. Work was principally sponsored or initiated by the CEL.

#### 4. AREA AND SCOPE OF EFFORTS

Efforts will be oriented primarily towards test and evaluation, and concentrated on the applications of solar panels for heating, photovoltaic cells and wind-mills. Other alternative energy sources such as ocean waves, ocean tides, and ocean thermal gradients will also be considered. At the same time energy conservation will be aggressively pursued in order to arrive at a baseline energy utilization. Water conservation from fog-drip will also be addressed. Efforts will progress according to the following general sequence:

- Collect and organize ideas
- Evaluate practicality/cost-effectiveness of ideas
- Conduct climatic studies for applications
- Dovetail with other Government/private efforts
- Design systems and prototypes
- Evaluate prototypes and systems
- Select specific test sites
- Develop, modify, adapt, fabricate, and procure components and systems
- Perform laboratory/in-site testing
- Install systems
- Perform on-site systems operation, test and evaluation  
(including maintenance and cost-effectiveness)
- Implement operational system and develop master energy program for future
- Consider and develop wider applications for Navy shore establishment

Some specific areas of emphasis will include:

- Roof-top solar panels on PACMISTESTCEN buildings
- Photovoltaic arrays
- Wind turbines at SNI
- Energy storage
- Hook-ups and integration into existing system
- Reliability
- Test and evaluation
- Climatic appropriateness
- Effects of atmospheric turbidity in the marine atmosphere on cell efficiency
- Prospects for long-term use and effectiveness
- Cost-effectiveness
- Community projects and tie-ins

Portable systems  
Tactical applications and field use  
Conservation and potential of battery-powered mini-buses for station transportation  
Utilization for heating in housing and work areas  
Application to noncritical operational systems

5. TEST SITES TO BE CONSIDERED

SNI - Receiver site, microwave facility and selected radar sites and building (photovoltaics, solar panels, wind turbines, fog drip). Also, at Marine Environment Test Site, use of wind turbines and ocean wave conversion.

Point Mugu - Beach sites, building tops, power plant, Geophysics Division, housing areas (photovoltaics, solar panels, ocean wave and tide conversion, wind turbines, fog drip).

Barking Sands - (Photovoltaics, solar panels, ocean wave conversion, and wind turbines).

Laguna Peak - (Wind turbines, solar panels).

Channel Islands - (Wind turbines).

Field Sites - Simulation of combat conditions (photovoltaics).

6. RESOURCES THAT WOULD BE REQUIRED

Labor

FY-79 Five summer employees - 1 month each plus 1 man-month professional, total approximately  $\frac{1}{2}$  man-year = \$15,000

FY-80 Ten summer employees - (2- $\frac{1}{2}$  man-years) plus  $\frac{1}{2}$  man-year - technician - data acquisition plus 1 man-year professional assistance  
Total 4 man-years  
\$108,000 including travel, computer (using combination of in-house and sponsor funds)

FY-81 Twenty summer employees (4 man-years) plus professional/technician assistance (4 man-years)  
Total approximately 8 man-years  
\$220,000 including travel, computer, hardware (using combination of in-house and sponsor funds)

## 7. MILESTONES

		<u>Date To Be Accomplished</u>
FY-79	Define task to summer employees	5 Aug 79
	Initiate project	15 Aug 79
	Generate ideas for consideration	1 Sep 79
	Develop FY-80 plans	30 Sep 79
FY-80	Formulate plans	1 May 80
	Establish PACMISTESTCEN Centers of Capability	1 Apr 80
	Compile, organize, and consolidate ideas	1 Jul 80
	Purchase and use photovoltaic cells	1 May 80
	Establish library	1 Aug 80
	Research ideas	1 Aug 80
	Investigate what's being done elsewhere	1 Aug 80
	Coordinate with other groups	1 Sep 80
	Travel to operational test site locations	1 Sep 80
	Formulate specific developmental plans	1 Sep 80
	Initiate component design	30 Sep 80
	Develop initial PACMISTESTCEN data base on solar insolation	30 Sep 80
	Develop initial climatic studies	30 Sep 80
FY-81	Design or adapt of components	
	Perform climatic studies and investigate trends	
	Investigate effects of atmospheric turbidity	
FY-82	Evaluate prototypes and system specification	
	Select specific test sites	
FY-83	Design, develop, procure, and adapt systems	
	Perform laboratory testing	
FY-84	Install systems	
FY-85	Perform on-site operation and maintenance	
FY-86	Perform test and evaluation	
FY-87	Implement operational system and master plan	
FY-88	Develop applications to Navy Shore Establishment	

8. TENTATIVE/POTENTIAL LIST OF INITIAL PARTICIPANTS

Principal Investigators

Jim Power, Energy Program Manager, Public Works Department  
Jay Rosenthal, Geophysics Division, Range Operations, Range  
Directorate  
Noel Van Slyke, Electromagnetics Division, Systems Technology  
Department, Systems Evaluation Directorate  
Les Maland, Project Management Group

Advisory Panel - Scientific Advisory Board

Project Engineering Manager

Chuck Elliott, Special Projects, Project Management Group  
Dick Unger, Planning, Project Management Group

Task Elements

Climatic applications and data summarization  
Climatic trends and spectral dependence of solar cells on  
atmospheric turbidity  
Statistical validation  
Numerical applications and models  
Photovoltaic effectiveness  
Wind system efficiencies  
Solar measurements  
Energy alternatives  
Measurement systems development  
Design of systems  
Fabrication  
Installation  
Portable systems  
Community relations  
Conservation  
Laboratory test and evaluation  
Safety

9. POTENTIAL SPONSORS

CEL  
NAVAIRSYSCOM  
NAVMAT  
NAVSEA  
NAVELEX  
DOE  
NASA  
PACMISTESTCEN  
NWC

in coordination with state, local, community, universities, and private  
interests.

APPENDIX B  
ENERGY PROJECTS SUGGESTED BY SUMMER EMPLOYEES - 1979

1. Mike Morrison (Code 4121)

As described in the following memorandum, energy conservation (lighting), inclusion of windows and skylights in building design, solar water heaters, wind generators, and wave/tidal power are offered as potential areas of application at the PACMISTESTCEN.

4121  
11310  
7 September 1979

MEMORANDUM (NOTE: Minor corrections made January 1980)

From: Mike Morrison, Summer Student, Code 4121  
To: Technical Director, Code 0002

Subj: Alternative Energy Sources at the PACMISTESTCEN

Ref: (a) Memo to Summer Students of 20 Jul 1979

1. Introduction:

In the 50s and 60s as industry in the United States began to skyrocket, a source of energy was found that was both plentiful and inexpensive, petroleum.

Engineers designed most systems with this plentiful energy source in mind, and so most designs sacrificed energy efficiency for the sake of materials efficiency. Large scale electricity systems were made, super-highways built and national resources invested in many other systems that are today considered to be very inefficient in terms of energy.

With the advent of the Arab oil embargo, it was realized that unlimited use of oil was to be very costly. Since much of PACMISTESTCEN was built during the period of plentiful energy, many of the energy systems were not built with energy conservation in mind and are very inefficient.

2. Energy Conservation:

The only real way to begin solving energy problems is energy conservation. Most alternative energy sources are less efficient than oil, so conservation is a must if we are to begin at least a short term solution at the PACMISTESTCEN. Throughout the facility, extensive use of overhead lighting is made. Most of the light from these lights is wasted, for it provides light bright enough for desks but is wasted on space lighting.

If the space lighting were kept to a minimum and portable or low level lamps used to light work areas, machines and desks, energy used for lighting could be dropped 30 to 50 percent without impairing worker efficiency. For example, the power rating for building 352 for lighting alone is roughly 80,000 watts. By turning off every other bank of lights and installing desk top lights at desks and work areas (which must be done anyway) a savings of over 30,000 watts could be realized, over 38 percent.\*

\*Assuming 40 watts for each desk fixture and 270 watts for each work area.

4121  
11310  
7 September 1979

Subj: Alternative Energy Sources at the PACMISTESTCEN

While there are rarely scorching days at Point Mugu, the design of many buildings (thin roofing, little insulation, no windows) causes many buildings to heat up and require air conditioning. Making windows and ventilation could use the normally comfortable air from the outside to be circulated through the building (highs are typically under 80 degrees). Windows could be closed as the day grew warmer in order to save the cool air of the morning, completely eliminating the need for air conditioning, except where sensitive equipment is stored.

Temperatures at Point Mugu average about 65 degrees with very little temperature fluctuation, so that proper ventilation and very little heating would be needed to keep buildings within a comfortable range. What little heating and cooling would be needed could easily be supplied by alternate forms of energy.

In the case of lighting, in the Design and Engineering Department, \$90,000 is spent annually. Much of it goes to lighting where \$20,000 could be saved by simply cutting down on the lights that are used needlessly.

### 3. Alternative Energy Forms:

By far the most efficient use of solar energy is to use it directly. This may sound obvious, but in many cases it seems to be avoided. Since most work at the PACMISTESTCEN is done during the day, many buildings could be fitted with skylights. With the use of this technique, no costly solar panels would be needed, just the addition of some glass panels and windows to the roof and walls of some of the buildings. Construction would be simple as the roofs of many buildings support little weight.

Electric lights would, of course, be installed for occasional use at night or for use during very cloudy weather. Diffusers for more even distribution of light would be necessary.

Solar panels are now only about 10 percent efficient and very costly. On the other hand skylights are very near 100 percent efficient and the price of glass panels is far less expensive than the price of solar panels for the same energy yield. As a bonus, costly fluorescent tubes would rarely need replacement.

Windmills were used extensively throughout the United States until the 1940s (when the Rural Electrification Agency extended power to the most rural areas). Wind is a proven means of energy conversion, even on the most rudimentary basis. New technology could make it far more efficient and much cheaper than it has been previously. Point Mugu has an average wind speed of 8 knots that makes it a feasible spot for wind generators.

4121  
11310  
7 September 1979

Subj: Alternative Energy Sources at the PACMISTESTCEN

Solar hot water heaters could be made from plastic bags colored black to absorb some of the solar radiation; these large heavy bags would be filled with heated water to either be stored or used. Stored water could be used to heat the building or used in the electroplating tanks in such buildings as 311. Here again would be a more direct way to use solar energy, and since Point Mugu receives an average of 400 Langleys (gram-calorie/cm<sup>2</sup>) per day, it could be very easy to heat water and store it for space heating.

Solar panels, hot water heaters, and wind generators could be used at remote weather stations and on some of the islands where it is expensive to transmit energy.

Locally, many of these systems could be mounted on the cantilevers of the aircraft hangers.

In the future, such exotic concepts as tidal energy could be implemented at the PACMISTESTCEN. The area adjacent to the F-14 simulator is in need of a tidal break, and drawing some of this destructive energy off for constructive purposes would be extremely beneficial.

Most of these suggestions are based on well-known, sound, and most importantly, inexpensive technology. These ideas could be utilized today.

Tidal energy is not in use at Point Mugu, but could be if research were started today.

MIKE MORRISON

Copy to:  
3253 (Jay Rosenthal)  
4121  
0030 (Bob Valles)



2. Stephen Cox (Code 1234)

Mr. Cox proposed the cultivation of algae ponds that can be used in the conversion to methane. This type of project would require selecting and constructing algae tank sites, equipment to harvest and process algae after drying, time to effect the required conversion, cost benefit analyses, development of plans to utilize methane, and close coordination with Mr. R. Dow, PACMISTESTCEN ecologist, to avoid adverse ecological impact.

3. Steven Nanning (Code 1243)

Mr. Nanning proposed consideration be given to the use of wave power at Point Mugu. He suggests that a diaphragm hydraulic system connected to an onshore turbine can be a substantial consistent source of clean power to the PACMISTESTCEN. Further details are provided in the following point paper.

Steven Nanning  
Code 1243

TITLE: The Proposal of New Energy Resources for the PACMISTESTCEN

PURPOSE: Investigate new energy resources.

ABSTRACT: Any introduction of new reserves to supplement future energy sources is desirable.

INTRODUCTION: Increasing costs and political liabilities of foreign energy sources make the development of new energy resources a practical idea for the future. In this development all potential sources must be given consideration. This includes wave and tidal power from the sea.

PROPOSAL: I believe that any consideration for alternate energy sources at PACMISTESTCEN should not ignore the potential power in wave and tidal motion. Point Mugu possess a high-energy beach face and the potential to implement a major wave-power station. The prevailing sea in the Point Mugu area is a 2 to 4-foot swell breaking close to shore in plunging breakers from left to right. A 3-foot breaker has an energy capacity of 2.7 horsepower per foot of width. I believe a diaphragm hydraulic system over a large area (50 to 100 yards) operating on the buoyancy principle and connected to a turbine on shore could be a substantial source of electric power that is both constant and clean. My idea is still conceptual in nature, but I will be happy to discuss it in greater detail.

Other ocean energy devices are in development, notably the CORIOLUS-ONE, a giant offshore turbine developed for use in the gulf stream and other major ocean currents. Experimental models of the CORIOLUS-ONE have been tested with favorable results. A prototype is now in production. The initial cost and development are high; however, once installed, they provide virtually cost-free energy on a constant, consistent basis.

CONCLUSION: Ocean wave power is an energy source that should not be ignored. Development should continue on current projects and new ones should be initiated. Only by exploring all energy reserves of land, sea, and air can the goal of supplemental energy be realized.

4. Eric Barrera (Code 1243)

Mr. Barrera suggests consideration of wind and solar energy devices to supplement the PACMISTESTCEN's future needs, but he feels that the test and development of such systems should be contracted to a power company in the private sector in order to devote existing manpower to the work of the PACMISTESTCEN's recognized mission. More details are provided in the following point paper.

Eric Barrera  
Summer Engineer  
Code 1243  
Ext. 8527

TITLE: On the Proposal of Wind and Solar Energy at the Pacific Missile Test Center

PURPOSE: Investigate the feasibility of wind and solar energy.

ABSTRACT: Any introduction of wind and solar energy to supplement future energy sources is desirable.

INTRODUCTION: The skyrocketing cost of fossil fuel and the liabilities of nuclear energy make the proposition of wind and solar energy a practical idea in the consideration of future energy resources in the Pacific Missile Test Center (PACMISTESTCEN).

PACMISTESTCEN AND ENERGY: While the evaluation of solar and wind energy may be beneficial in the future, it must not divert PACMISTESTCEN from its mission. The PACMISTESTCEN Technical Capabilities Guide states:

The mission of PMTC [PACMISTESTCEN] is to perform test and evaluation, development support, and follow-on engineering to provide logistics and training support for naval weapons, weapon systems, and related devices; and to provide major range, technical and base support to Fleet users and other Department of Defense and Government agencies.

During the test and development, there will be some burden on, though not enough to disrupt, the physical plant and technical capabilities of the PACMISTESTCEN. The presence of solar collectors and wind apparatus may interfere with radar transmission. Personnel will be needed for the project. This will decrease the available human resources of the PACMISTESTCEN.

CONCLUSION: The most favorable solution would be to acquire, by contract, the services of the power company. The test and development of wind and solar energy will be performed by the power company. Although the facilities and personnel will still be needed, to coordinate and ensure proper guidelines are followed, the amount will be considerably less than before--if the PACMISTESTCEN performs the task alone. The mission of the PACMISTESTCEN is preserved and the goal of supplemental energy resources is realized.

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